

**ENGN/PHYS 207**  
**Washington and Lee University**  
**Electrical Circuits with Lab**  
**Fall 2019**

Course Web Page: [http://home.wlu.edu/~ericksonj/circuits\\_f2019.html](http://home.wlu.edu/~ericksonj/circuits_f2019.html)

Cool stuff you will learn in this class

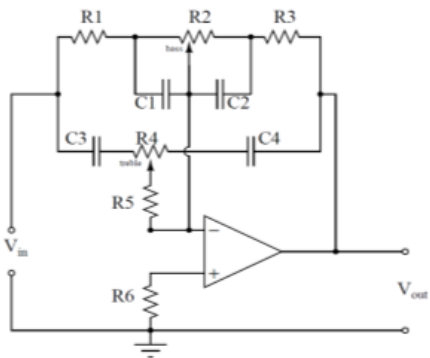
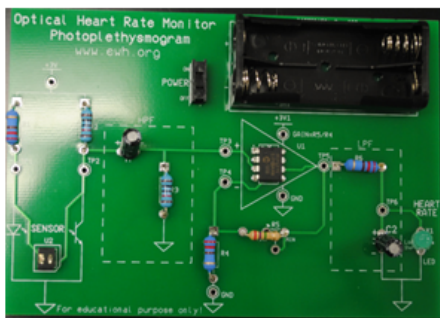
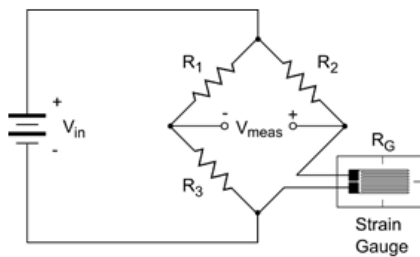


Figure 1: Examples of the broad range of circuits applications. And this barely scratches the surface! Top: Strain gauge in Wheatstone Bridge circuit to monitor structural health of airplane wing. Middle: Optical heart rate monitor on a classic printed circuit board, and new school miniaturized version in mobile device. Bottom: Baxandall tone control of bass and treble in audio amplifier. Circuits and music? Yes, please!

## Course Meeting Info

**Lecture:** MW 2.45 - 4.15 pm, Sci Ad G16  
**Lab-Section 01:** Th 8:30 – 11:30 am, Howe 111  
**Lab-Section 02:** Th 1:30 – 4:30 pm, Howe 111

## Instructor Info

Instructor: Jon Erickson  
Office Hours: MTW 10.30am - noon  
and by appointment (walk-ins welcome!)  
Where to find me: Howe 221 (office) or Howe 222 (research lab)  
Phone: 458.8293 (office) or 458.8889 (research lab)  
Email: ericksonj@wlu.edu

## Course Text

*Basic Engineering Circuit Analysis–11 ed., JD Irwin and RM Nelms, 2015, ISBN: 978-1-118-53929-3.*

## Introduction and Course Objectives

*Circuits are everywhere, whether hiding or in plain-sight. How many circuits/electronic gadgets have you used today? I'd wager my first- and second-born the answer is strictly  $> 0$ . (In the event I'm wrong, Ella and Anna are great. They are little comedians, and quite helpful in the lab, so you'll have a great time together.) Indeed, electrical circuits are everywhere! Toast a bagel or brew coffee this morning? Use a swipe machine or credit card recently? Turn on a heater to stay warm last night or blow dry your hair this morning? Me too! Well, except for the dry your hair part. You get the idea—practical circuits are ubiquitous.*

*While circuits are manifestly useful, at first glance they can look like a tangle of strange looking symbols. Even the not-so-messy ones can be intimidating (or look deceptively simple). In this course, you will have ample opportunity to gain a lot of hands-on practical experience, to become comfortable building circuits and to master the laboratory techniques to test and analyze circuits. Emphasis is placed **becoming confident and independent in design, building, testing, and analyzing circuits that you may encounter in your everyday life—and future careers.** You will emerge from this course fluent in basic circuit design, analysis, and construction. In this context “fluency” is defined as being able to:*

- *Understand the basic physics underlying the behavior of various components (resistors, capacitors, inductors, amplifiers, diodes, transistors)*
- *Design, build, and analyze various useful circuits (filters, amplifiers, digital displays) from scratch.*
- *Do the math—e.g., quantitative techniques to design and analyze circuits*
- *Debug a basic circuit: Open a device, trace the circuit, analyze its operation and intended purpose, then fix it.*

## Community Based Learning

*This fall is an especially exciting time in Circuits: We are partnering with the Rockbridge YMCA to enrich the after school science programming for 3-5 graders!*

*The after school program will take place at two sites: Central Elementary and Waddell Elementary. The program runs on Mondays from 3-4 pm. Please be mindful that we need to arrive early to set up and also break-down/clean up afterward.*

*We will have 6 weeks total working with local area students participating in the Y after school program (see Daily Course Schedule). Student teams from the Circuits course will run 3 consecutive weekly sessions. Repeat exposure and familiar faces help build rapport with the elementary students and the program.*

*In practical terms, this means that our merry Circuits crew will develop and implement after-school modules based on course material. For example, we'll build soil-moisture sensors, gesture sensing gloves, and materials sensing resonant circuits, to name a few. And teaching something is the best way to learn it. Developing such modules is guaranteed to be a fun and challenging adventure.*

*You will also be asked to write short, critical reflections to evaluate the merits/successes of each module—which will also serve to improve the CBL content as the years progress. This reflection pieces are also intended to help you understand the role of engineers in society, including inspiring and developing the next generation.*

*In summary, the purpose of incorporating this site-based CBL component is to **benefit you, the community partner, and the greater good.***

*CBL Student Learning Outcomes are as follows:*

- *Analyze the mission, structure, and work of community partners in addressing the public good.*
- *Collaborate effectively and respectfully with community-based learning partners, faculty, students, and/or other stakeholders to meet community-defined aspirations and interests.*
- *Integrate classroom learning experiences with community learning experiences.*
- *Articulate how community-based learning contributes to the evolution of students' personal, professional, academic, and/or civic identities.*

## Material Covered

For a more complete list, please see the Course Schedule on the course website. A summary of the topics we will cover follows below:

DC and AC analysis techniques including: Ohm's Law, Kirchoff's Laws, phasor analysis and impedance; RLC resonant circuits; passive RC filters; op-amps and active filters; semiconductor devices including LEDs, transistors; binary math; digital logic, intro microcontrollers (Arduino/Teensy).

## Integrative Course Assignments

All assignments will be based around laboratory work—i.e. building, testing, and analyzing real-world circuits. As such, assignments will integrate theoretical and practical components. In lay terms, on each assignment, you'll be asked to:

1. Build a circuit and make measure voltage and current to see how it works in practice
2. Do the math to analyze how it is supposed to be work in theory
3. Compare and explain how and why theory and experiment agree (or not)

The assignment schedule is based on the laboratory schedule. Expect there to be about 7 of these throughout the term, spaced approximately 1 week apart during the first half of the term, and 2 weeks apart during the second half of the term. The semester will culminate in a multi-week Final Design Project.

Assignments submissions will always be due before the day before next lab assignment begins. For example, we'll have our first real lab day 05 Sept (first day of classes), and the due date will be 5pm Wednesday 11 Sept.

Each integrative assignment must be revised, as needed, until it crosses a threshold of very good to excellent, marked "VGE". An assignment marked "RR" indicates some aspects of your submission merit significant improvement, and you must submit a revision. In this case, you must meet with the instructor to review your work to discuss what needs to be improved and how to improve it. It is *your* responsibility to stop by office hours and/or set up a meeting time. Grades on these assignments will be awarded as follows, based on when the VGE is achieved:

1. Original submission: A+ (100)
2. Revision 1: A (95)
3. Revision 2: B+ (87)
4. Revision 3: C- (72)
5. Revision  $\geq$  4: D- (62)

This revision process is intended to help you 1) fully comprehend core concepts in Circuits; and 2) foster your overall scientific writing capability. With a good faith effort from the student, the instructor fully expects that the revision process should typically conclude with the assignment receiving a grade of no lower than B+.

## CBL Preparation and Reflection Assignments

For the weeks you participate in the CBL component of this course (YMCA after school science enrichment): 1) Students will work collectively to develop an age appropriate 'lab manual', replete with photos guiding elementary school students through the build, and also guiding them to learn about some core circuits principles (e.g. What is an electrical circuit? What do we mean by resistance? How does this sensor work?)

2) Each student is required to submit a 1-page written reflection. This document should briefly recap what went well with the experiment; identify any hiccups and suggest future improvements; address what you learned Circuits-wise; and reflect upon the impact the program is (or isn't) having on the community.

## Exams

We will plan for 2 total exams:

1. "Quick" 1-2 hour exam covering DC basics.
2. Comprehensive final exam  $\approx$  4-hr.

See the course schedule for exam dates. In general, exams will be closed book, closed note, calculators permitted only for numeric computation. I will provide you with all relevant reference material (e.g., equation sheet). No late exams will be accepted.

## Design Project

There will be one open-ended, integrative design project. While it will serve to help assess your level of mastery of course material, even more importantly, it will also provide an opportunity to work on a "real-life" design project. You'll have multiple weeks to tackle the design project toward the end of the term.

## Grading Policies

1. **You must satisfactorily complete all lab assignments in order to pass this class. You must also pass a soldering proficiency test in order to pass this class (Think: engineers/physicists version of the swim test).**
2. Assignments submitted after the due date without prior approval from the instructor will incur a 5%/day deduction from Integrative Assignment score (50 points total over the term). Of course, reasonable exceptions are made in extenuating circumstances.
3. **No grade will be awarded for the course until your lab station is verified to be clean and tidy, with every part put back in its original and proper place at the end of the term.**
4. Numeric grades are tabulated as follows:

<i>Integrative Assignments/Labs</i>	<i>30%</i>
<i>CBL Participation and Written Reflection</i>	<i>15%</i>
<i>Exam 1</i>	<i>5%</i>
<i>Final Exam</i>	<i>20%</i>
<i>Design Project</i>	<i>25%</i>
<i>Intellectual growth, independence, class participation</i>	<i>5%</i>
<hr/> <i>Total</i>	<hr/> <i>100%</i>

Your final state of competence is more important than your overall numerical average. The subjective component is simply a mechanism by which—when appropriate—I can translate your final state into an appropriate letter grade. Throughout the term we will have many occasions to interact in the classroom and in the lab. At the end of the 12 weeks together I gain a very good sense for placing students on the spectrum of who really “knows their stuff.” Factors considered during this evaluation include, but are not limited to: class and lab participation, intellectual growth, demonstrated overall integrity and competency in course and lab work. Please know that this policy is in place neither to hurt or help you. If you have any questions about this grading policy, please come talk to me.

One piece of information regarding this grading system that may assuage and/or allay any concerns or fears you may have—maybe even bolster your spirits: The median grade earned by students completing Circuits the prior four years is roughly an A-, and approximately 30% of students have earned an A. That is not to say this class is easy (just ask Circuits alumni!), rather that it is possible to master Circuits, and excellent performance is duly recognized.

# COURSE POLICIES

## Integrative Assignment Policy

You are allowed and strongly encouraged to discuss integrative assignment problems with class mates, but your written solutions must be generated by you alone. Consultation with or seeking aid from solutions from previous offerings of this course is strictly forbidden.

## Lab Work/Data Sharing Policy

This term, you will work with a classmate (team of 2) during all lab sessions. It is crucial that both you and your lab partner actively participate to master the core skill set in the Circuits lab. You are allowed and encouraged to *share raw data*. However, **each student must generate his or her own final graphics/figures from (shared) raw data**. Reasonable accommodations are made by the instructor with regard to sharing files that generated in collaboration with your lab partner, but you must **ask first**.

## CBL Assignments

Collaborate, talk it up, share your experiences with each other! You can integrate thoughts and ideas from those discussions with your own experience into your own CBL written reflection.

## Exam Policy

Any collaboration on, or discussion pertaining to, exams is strictly prohibited.

## Design Project Policy

Expect to work with a team member on your final project. You may of course fully collaborate with your team member, but collaboration and discussion with anyone else is strictly prohibited. The final written report must be developed by you, working solo.

## Academic Honesty

According to the White Book<sup>1</sup>, the Honor System is the “fundamental principle that a spirit of trust pervades all aspects of student life.” The system is one of “mutual trust” which clearly establishes that “Students should do their own work, represent themselves truthfully, and claim only that which is their own” (emphasis added by JE). The system is not designed to “work against or frighten” students, rather it was designed to allow students “unparalleled academic freedom.”

You are expected to abide by the W&L Honor System at all times. Any suspected Honor Violation will be reported to the Executive Committee. In such an event, the instructor reserves the right to assign a grade of zero on that assignment and/or a failing grade for the course. (I believe in my heart that this policy will never ever come into play, but I am, more or less, legally compelled to explicitly state it in the official course syllabus.) Specific policies regarding homework assignments, lab reports, and exams are described in detail below. If you are ever in doubt about whether an action is within bounds, please consult with me first.

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<sup>1</sup>Full text of White Book available at <http://www.wlu.edu/x48217.xml>

## Special Academic Accommodations

Washington and Lee University makes reasonable academic accommodations for qualified students with disabilities. All undergraduate accommodations must be approved through the Office of the Dean of the College. Students requesting accommodations for this course should present an official accommodation letter within the first two weeks of the (fall or winter) term and schedule a meeting outside of class time to discuss accommodations. It is the student's responsibility to present this paperwork in a timely fashion and to follow up about accommodation arrangements. Accommodations for test-taking should be arranged with the professor at least a week before the date of the test or exam.

## Attendance Policy

### Class Periods

You are *strongly encouraged* to attend all lectures—hopefully they are worth attending. We'll be doing a lot of hard thinking, working on problems, learning by doing in the lab (but minimal straight-up old school lecture). In order to make optimal use of our 90 min together, *before class* please read and/or watch assigned material, and do your level best to understand core concepts. (Learning how to learn...a life-long skill...two for the price of one in Circuits...hooray!)

If you miss class for a legitimate reason—illness, family emergency, etc.—I will make every effort to help you get caught up as soon as possible. You must notify me (in person or via email) of a planned excused absence prior to day you will miss to briefly explain the circumstances. In the event of an unexcused absence (i.e., “Whoops, I slept in”; “I had paper due for another class”; “I left a day early for Thanksgiving Break”, etc.), you are solely responsible for staying up to date with class notes and news—in which case, I strongly recommend talking to a Circuits buddy.

### Lab Periods

The laboratory sessions are crucial for learning hands-on, practical skills relating to electric circuits. Therefore, *you must satisfactorily complete all labs during the assigned laboratory period*. Of course, any extenuating circumstances will be carefully considered, should they arise. If you are unable to attend a laboratory session on the assigned day for a legitimate reason, notify me *in person or by email before the lab* to explain the circumstance, and I will arrange for a time to make-up the lab, and do everything reasonable within my power to help you with the lab. *In the event of an unexcused absence, you are still required to complete the laboratory, but no assistance from the instructor and/or TA will be offered.*

### Note on Athletics

Sanctioned athletic competitions, but not practice sessions, qualify as an excused absence. Please notify me of an athletic absence well in advance of the athletic event.

### Sick Day Policy

If you are feeling ill, please stay home, get some rest, get a friend to bring you notes from class and chicken soup and get better soon! It is in everyone's best interest for you to minimize interpersonal contact when you are feeling sick, especially when you are symptomatic. I trust your judgment and



do not require a doctor's note. However, please remember to contact me regarding this absence, and feel better soon!.

## Electronic Devices and Texting



Figure 2: Circuits is a No Texting Zone.

*I would like to believe I am a pretty easy-going, congenial guy, but the one thing that absolutely drives me bonkers is texting during class. The two-hands under the desk, half-blank stare is obvious. So, thank you in advance for powering down your mobile device, and for respecting the strict no-texting policy.*

*If you must have your phone on for tending to, say, a medical or family emergency, please inform me before the start of class.*

*Regarding laptops in class: There isn't really any compelling reason why you would use one in Circuits on a day-to-day basis, and a grand total of zero students have sought to use one in 8 previous years I've taught this course. However, if you have insist on using a laptop, please ask me first—any reasonable requests will be entertained and carefully considered (but I do not promise to grant it). All of this said, there are days when we will make use of Matlab or other software packages to perform analysis; you'll be given ample advance notice.*

## Suggestions and Feedback

*Suggestions for improvement, constructive criticism, and positive feedback are welcome at anytime. Please do not hesitate to approach me with any concerns you may have about this course. I take your feedback very seriously and will sincerely respond to all received comments. It is the main mechanisms by which the course will improve over time (sometimes instantaneously, when possible!).*